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PATENT APPLICATION

DEFLECTION YOKE AND CATHODE RAY TUBE DEVICE

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CROSS-REFERENCES TO RELATED APPLICATIONS

[01] The present application is related to and claims priority from Japanese Patent Application No. 2001-356855, filed on November 22, 2001, and Japanese Patent Application No. 2002-280152, filed on September 26, 2002.

BACKGROUND OF THE INVENTION

[02] The present invention relates to a display device, and particularly to a cathode ray tube including a deflection yoke and a display device thereof.

[03] In one conventional technique, a horizontal auxiliary coil and a vertical auxiliary coil are wound toroidally about a main core, and a horizontal auxiliary transformer or a vertical auxiliary transformer is provided to cancel a voltage induced from a main deflection yoke (see, FIGs. 3 to 5 of Japanese Patent Laid-Open No. 2-129846). The main core defines the sole deflection yoke in this art.

[04] In another conventional technique, a portion of a coil of a main deflection yoke is wound about a minor core (see, FIG. 1 of Japanese Patent Laid-Open No. 2000-21330). Accordingly, the portion of the coil wound about the minor yoke cooperates with a portion of the coil wound about the main core to more finely control the trajectory of electrons passing through the main and minor cores, i.e., increase the deflection sensitivity.

BRIEF SUMMARY OF THE INVENTION

[05] In first conventional technique, the deflection sensitivity is reduced since it is necessary to provide a horizontal auxiliary transformer or a vertical auxiliary transformer, which also increases the manufacturing cost. Manufacturing such a deflection yoke also is more complicated, thereby raising reliability concerns.

[06] The second conventional technique, on the other hand, provides an improvement in sensitivity of a main deflection yoke since a portion of a coil of a main deflection yoke is wound about a minor core. However, no mechanism is provided for improving the sensitivity of the minor deflection yoke. Additionally, a crosstalk voltage results from a magnetic field

leakage of the main deflection yoke to the minor deflection yoke, thus interfering with the operation of the minor deflection yoke with respect to a drive circuit..

[07] A deflection yoke according to one embodiment of the present invention improves deflection sensitivity of a minor deflection yoke and reduces or suppresses a crosstalk voltage. The deflection yoke can be manufactured with a simplified configuration at a lower cost.

[08] In one embodiment, an electron beam trajectory controlling device includes a main deflection section having a first main coil and defining a first path and being configured to control a trajectory of an electron traveling along the first path. The main deflection section includes a first auxiliary coil provided proximate the first main coil. A minor deflection section is provided adjacent to the main deflection section and has a first minor coil that is coupled to the first auxiliary coil. The minor deflection section defines a second electron path that is aligned to the first path. The minor deflection section cooperates with the main deflection section to control the trajectory of the electron.

[09] In one embodiment, a device for deflecting an electron beam includes a main deflection section defining a first path and being configured to deflect the electron beam traveling along the first path. The main deflection section provides a coarse deflection control of the electron beam. The main deflection section includes a first main conductive component configured to generate a magnetic field to deflect the electron beam traveling along the first path in a first direction, a second main conductive component configured to generate a magnetic field to deflect the electron beam traveling along the first path in a second direction, a first auxiliary conductive component, and a second auxiliary conductive component. A minor deflection section is provided adjacent to the main deflection section. The minor deflection section defines a second path that is aligned to the first path and provides a fine deflection control of the electron beam. The minor deflection includes a first minor conductive component that is coupled to the first auxiliary conductive component and configured to deflect the electron beam along the first direction, and a second minor conductive component that is coupled to the second auxiliary conductive component and configured to deflect the electron beam along the second direction. The first auxiliary conductive component cooperates with the first minor conductive component to reduce a crosstalk voltage generated in the minor deflection section. The first minor conductive component is not coupled to the first major conductive component.

[10] In another embodiment, a cathode ray tube includes a display surface and a deflection assembly. The deflection assembly includes a main deflection section having a first main coil and defining a first electron beam path and being configured to control a trajectory of an electron beam traveling along the first path. The main deflection section includes a first auxiliary coil provided proximate the first main coil. The assembly also includes a minor deflection section provided adjacent to the main deflection section. The minor deflection section has a first minor coil that is coupled to the first auxiliary coil and defines a second electron beam path that is aligned to the first electron beam path. The minor deflection section cooperates with the main deflection section to control the trajectory of the electron beam.

[11] In yet another embodiment, a display device includes a housing having an opening and a cathode ray tube provided within the housing and having a display surface, the display surface aligned to the opening of the housing. The cathode ray tube includes a main deflection section having a first main coil and defining a first electron path and being configured to control a trajectory of an electron traveling along the first electron path, the main deflection section including a first auxiliary coil provided proximate the first main coil. The tube also includes a minor deflection section provided adjacent to the main deflection section and having a first minor coil that is coupled to the first auxiliary coil, the minor deflection section defining a second electron path that is aligned to the first electron path, the minor deflection section cooperating with the main deflection section to control the trajectory of the election. The inductances of the first auxiliary and minor coils are set to satisfy the following condition, $0.005 \leq L_{a1}/L_{m1} \leq 0.7$, where L_{a1} denotes the inductance of the first auxiliary coil and L_{m1} denotes the inductance of the first minor coil.

BRIEF DESCRIPTION OF THE DRAWINGS

[12] FIG. 1A is a block diagram of a cathode ray tube device according to the embodiment of the present invention;

[13] FIG. 1B is a schematic cross sectional view of a deflection yoke according to one embodiment of the present invention;

[14] FIG. 2 is a schematic sectional view taken on A-A' of a deflection yoke according to one embodiment of the present invention;

[15] FIG. 3 is a schematic sectional view taken on B-B' of a deflection yoke according to one embodiment of the present invention;

[16] FIG. 4 is a schematic sectional view taken on A-A' of a deflection yoke according to one embodiment of the present invention;

[17] FIG. 5 is a schematic sectional view taken on A-A' of a deflection yoke according to one embodiment of the present invention;

[18] FIG. 6 is an explanatory view of the principle involved in one embodiment of the present invention;

[19] FIG. 7 is an explanatory view of the principle involved in one embodiment of the present invention;

[20] FIG. 8 is an explanatory view of the principle involved in one embodiment of the present invention; and

[21] FIG. 9 is a characteristic view of deflection sensitivity according one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[22] While the present invention has been described herein using several embodiments thereof, it should be understood that the disclosed embodiments might be altered or modified without departing from the scope of the invention. Therefore, the scope of the present invention should be interpreted using the appended claims.

[23] A deflection yoke assembly and a cathode ray tube of a display device, according to embodiments of the present invention, will be described below with reference to FIGs. 1A to 9. FIG. 1A shows a display device 200 having a housing 202 and a cathode ray tube provided with a deflection yoke assembly 1 according to one embodiment of the present invention. The display device is a television or a computer monitor according to one embodiment of the present invention. The display device includes a cathode ray tube 9, a deflection yoke assembly 1, a high voltage circuit 91, a video circuit 92, a horizontal deflection circuit 93, a vertical deflection circuit 94, a horizontal drive circuit 95, a vertical drive circuit 96, a video signal input terminal 97, a horizontal synchronous signal input terminal 98, and a vertical synchronous signal input terminal. Herein below, the same

component names and numerals are used to refer elements or features that are similar to above-mentioned elements or features.

[24] Referring to FIGs. 1B to 3,reference numeral 1 designates a deflection yoke assembly, which is arranged in a cathode ray tube, and a fluorescent surface is provided on a left side 102 of the deflection yoke assembly. The deflection assembly 1 includes a first or main deflection yoke 2 (or main deflection section), a second or minor deflection yoke 3 (or secondary deflection yoke), a main core 41, a minor core 42, a main horizontal coil 5, a second auxiliary horizontal coil 6, a first auxiliary horizontal coil 71, a first vertical coil 72, and a main vertical coil 8. The main deflection yoke is provided proximate the fluorescent surface, and the minor deflection yoke is provide proximate an electron gun (not shown) and remote from the fluorescent surface according to one embodiment of the present invention. Since the minor deflection yoke 3 (i.e., the minor core) has a smaller inner diameter than that of the main deflection yoke 2 (i.e., the main yoke), the minor deflection yoke provides a higher deflection sensitivity than the main deflection yoke.

[25] The main and minor cores 41 and 42 are metallic (e.g., iron) cylindrical-shaped objects whereupon respective coils are wound. The main horizontal and vertical coils and the first auxiliary horizontal and vertical coils are provided on the main core 41. The second auxiliary horizontal and vertical coils (or minor horizontal and vertical coils) are provided on the minor core 42. The first and second auxiliary horizontal coils are connected to each other in series or parallel. The first and second auxiliary vertical coils are connected to each other in series or parallel. The main horizontal and vertical coils are not coupled to the corresponding minor horizontal and vertical coils (or second auxiliary horizontal and vertical coils).

[26] In one implementation, the deflection yoke assembly 1 includes the first auxiliary horizontal coils 71 and the first auxiliary vertical coils 72 that are wound toroidally about the main core 41, a terminal 711 of the first auxiliary horizontal coil 71 connected to the second auxiliary horizontal coil 6 in series or parallel, and a terminal 721 of the first auxiliary vertical coil 72 connected to a terminal 431 of a second auxiliary vertical coil 43 in series or parallel. While in FIG. 2, the first auxiliary horizontal coils 71 and the first auxiliary vertical coils 72 are respectively connected in series. In another implementation, they are connected in parallel.

[27] As used herein, the term "deflection yoke assembly" refers to a device or component that is used to deflect or control a trajectory of an electron beam. The term "main deflection section" refers to a device or component in an electron beam deflection controlling device, e.g., a display device, cathode ray tube, or deflection yoke assembly, that provides a coarse deflection control of an electron beam traveling along a path. An example of the main deflection section is the main deflection yoke described herein. The term "minor deflection section" refers to a device or component in an electron beam deflection controlling device, e.g., a display device, cathode ray tube, or deflection yoke assembly, that provides a fine deflection control of an electron beam traveling along a path. An example of the minor deflection section is the minor deflection yoke described herein.

[28] Referring back to Fig. 1A, a video signal is input from the video signal input terminal 97, and the signal is processed by the video circuit 92 and afterward supplied to a cathode of the cathode ray tube 9. A horizontal synchronous signal is input from the horizontal synchronous signal input terminal 98, and the signal input is supplied to the horizontal deflection circuit 93 to generate a horizontal deflection current. The horizontal deflection current generated is supplied to the main horizontal coil 5 of the deflection yoke assembly 1. Further, the horizontal synchronous signal is supplied to the high voltage circuit 91 and a high voltage is applied to an anode of the cathode ray tube 9. A vertical synchronous signal is input from the vertical synchronous signal input terminal 99, and the signal input is supplied to the vertical deflection circuit 94 to generate a vertical deflection current. The vertical deflection current generated is supplied to the main vertical coil 8 of the deflection yoke 1. In this manner, the cathode ray tube device is driven.

[29] When the deflection yoke assembly 1 of the present embodiment is applied to the cathode ray tube device, high sensitivity and a low crosstalk voltage can be realized with a relatively simple device design. Accordingly, the cathode ray tube 9 requires significantly less power to drive the horizontal drive circuit 95 and the vertical drive circuit 96, as described in more detail below.

[30] FIG. 4 illustrates a cross-sectional view of the main core 41 taken along an arrow A-A' according to another embodiment of the present invention. In FIG. 4, the first auxiliary horizontal coil 71 includes first and second sub coils 712 and 713 to be wound about the main core and the first auxiliary vertical coil 72 includes sub first and second coils 722 and 723 to be wound about the main core. A magnetic field distribution formed by the sub horizontal

coils 712 and 713, and the sub vertical coils 722 and 723 shows a uniform magnetic field distribution, which facilitates in reducing the crosstalk voltage.

[31] In another embodiment, the first auxiliary horizontal coil 71 and the first auxiliary vertical coil 72 are formed using a saddle-winding method within the first deflection yoke 2, thereby obtaining similar effects as described above.

[32] FIG. 5 shows a cross-sectional view taken on A-A' of a main deflection yoke 2 according to another embodiment of the present invention. As in elsewhere, the same names and numerals are used to refer elements or features that are similar to above-mentioned elements or features. For example, the main deflection yoke 2 of Fig. 5 uses the same name and numeral as that of Fig. 2 although they refer to different, yet similar components. The main deflection yoke 2 of Fig. 5 includes a main core 41 having a plurality of markings 102 on its inner surface or outer surface, or both. The markings 102 are configured to facilitate precise wounding of the first horizontal and vertical auxiliary coils 71 and 72 about the main core. In one embodiment, the markings 102 are provided by varying the thickness of the main core 41, e.g., indentations are made on portions of the main core 41 whereon the first horizontal and vertical auxiliary coils 71 and 72 are to be wound toroidally. The indentations can be made on the inner surface or the outer surface, or both. With such markings, the auxiliary coils can be wound more easily and precisely, thereby providing a greater deflection sensitivity for the deflection assembly 1. In one embodiment, similar markings are provided on the minor core 42 to facilitate precise wounding of the second auxiliary vertical and horizontal coils.

[33] FIGs. 6 to 8 illustrate a principle used to suppress a crosstalk voltage according to one embodiment of the present invention. The main horizontal coil 5, the second auxiliary horizontal coil 6, and the first auxiliary horizontal coil 71 are used in this illustration. A magnetic field leakage 51 generated by the main horizontal coil 5, as shown in FIGs. 7 and 8, passes through the minor core 42 arranged in the minor deflection yoke 3 from the neck side (e.g., the left side of the minor deflection yoke 3 in FIG. 7) of the main deflection yoke 2, generating a crosstalk voltage in the second auxiliary horizontal coil 6.

[34] However, as shown in FIG. 6, a winding direction of the first auxiliary horizontal coil 71 is arranged so that a "reverse crosstalk" voltage is generated by the first auxiliary coil 71. The first auxiliary coil 71 provided on the main coil 41 is coupled to the second auxiliary coil

6 via the terminal 711. Accordingly, the "reverse crosstalk" voltage offsets or suppresses the crosstalk voltage generated in the second auxiliary coil 6, thereby significantly reducing the crosstalk voltage across a terminal 420 and a terminal 710. This provides substantial improvement in dynamic range of a drive circuit associated with the deflection yoke.

[35] Referring to FIGs. 7 and 8, a first auxiliary horizontal magnetic field 714 generated by the first auxiliary horizontal coil 71 and a second auxiliary horizontal magnetic field 61 generated by the second auxiliary horizontal coil 6 are generated in the same direction, that is, these magnetic fields are added, thereby significantly increasing the deflection sensitivity. While the above description has been made using the main horizontal coil 5, the second auxiliary horizontal coil 6, and the first auxiliary horizontal coil, a similar effect can be obtained from the main vertical coil 8, the first auxiliary vertical coil 72, and the second auxiliary vertical coil 43.

[36] FIG. 9 shows a characteristic of deflection sensitivity of a minor deflection yoke 3 of a deflection yoke assembly 1 according to one embodiment of the present invention. In FIG. 9, L_{s1} refers to an inductance of the first auxiliary horizontal coil 71, L_{s2} refers to an inductance of the second auxiliary horizontal coil 6, a Y-axis represents a relative power index of the minor deflection yoke 3, and an X-axis represents the ratio of L_{s1} over L_{s2}. The Y-axis also represents the deflection sensitivity of the deflection yoke assembly 3, where the sensitivity increases as the relative deflection power index decreases.

[37] Values of the L_{s1} and L_{s2} vary according to the number of turns wound about the main and minor cores 41 and 42. In one embodiment, the value L_{s1} is obtained by wounding a coil toroidally about the main core 1-8 times (i.e., 1-8 turns), preferably 2-6 times, more preferably 2-5 or 3-4 times. The value L_{s2} is obtained by wounding the same type of coil toroidally about the minor core 10-50 times (i.e., 10-50 turns), preferably 15-40 times, more preferably 20-30 times. In the present embodiment, the main core 41 has an outer radius (R1) of 55 mm, and an inner radius (R2) of 48 mm (i.e., a thickness of 3.5 mm), and the height or length (L1) of 28 mm. The minor core 42 has an outer radius (R3) of 42 mm, and an inner radius (R4) of 31 mm (i.e., a thickness of 5.5 mm), and the height or length (L2) of 15 mm.

[38] Referring back to FIG. 9, a point 300, where X is 0 and Y is 1, represents a situation where the deflection yoke assembly 1 has only the second horizontal auxiliary coils on the minor core 42 and no first auxiliary horizontal coils on the main core 41.

[39] Generally, if the relative deflection power index is improved by 5% or more, a significant improvement can be obtained in reducing loss of power (about 4%), i.e., power consumption, by the horizontal drive circuit 95 and the vertical drive circuit 96 of FIG. 1A. In one embodiment, this 5% improvement occurs at a point 302 where X is 0.007, at a point 304 where X is 0.7. While improving sensitivity, this reduction in power loss also enables use of a smaller radiation plate to dissipate heat generated in the periphery circuitry. If the relative deflection power index is improved by 10% or more, a rating of a transistor of the horizontal drive circuit 95 and the vertical drive circuit 96 can be made small by one rank, enabling a considerable reduction in cost. The 10% improvement occurs at a point 306 where X is 0.005 and at a point 308 where X is 0.6. An even better result may be obtained at a point 310 where X is between about 0.1 to about 0.3 or a point 312 where X is between about 0.1 to about 0.2.

[40] Accordingly, the present inventors have discovered that the deflection yoke assembly 1 of the display device consumes low power and provides high sensitivity when the inductances of the first and second auxiliary coils are set with the following parameters: $0.005 \leq L_{s1}/L_{s2} \leq 0.7$, or preferably $0.007 \leq L_{s1}/L_{s2} \leq 0.6$, or more preferably $0.01 \leq L_{s1}/L_{s2} \leq 0.2$. The power index issues described above using the first and second auxiliary horizontal coils similarly apply to the first and second auxiliary vertical coils as well.

[41] According to the embodiments described above, an improved display device having a deflection yoke assembly that provides a simplified design, increases the deflection sensitivity, decreases the relative power index, and reduces a crosstalk voltage. The deflection yoke assembly includes a main deflection yoke where a first auxiliary coil is provided and a minor deflection yoke where a second auxiliary coil is provided. The auxiliary coils are coupled to each other in series or parallel.

[42] The above embodiments have been used merely to describe the present invention and should not be used to limit the scope of the present invention. Accordingly, the scope of the present invention is defined according to the appended claims.